D0 Upgrade Electronics

D0Note xxxx

On the Possibility of a Wide Connector Design for the CFT

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1. Introduction

The design of the CFT/CPS FE boards has been changed. [1] In the new design the digital or track finding portion of the former FE board is split off and located on a separate board in a remote location. One of the major features of the former design was the necessity of a large backplane to transfer the discriminated signals from one trigger sector to the adjacent for a seamless trigger. The new design avoids a FE backplane by sending the signals, which formerly were passed over the backplane, on duplicate links to the neighbor digital board, DG. Another major feature of the former design was a patch panel for the optical wave-guides because 1/80th of the detector was input into each 1/2 cassette. In this scheme a ribbon on the detector, 128 x 2 in phi, was plugged into a patch panel which converted this into a 8 x 2 in radius.

An obvious question now is: "With the new separated Fe design, is a patch panel still necessary?" This note addresses this question

2. General Information

There are several features of the detector and FE electronics, which relate directly to this discussion. They are listed here.

- *The CFT detector barrels have a 5-fold symmetry. The ribbon topology of the detector repeats 5 times in the phi direction or every 72 degrees. Call each 1/5th detector a SECTION. Each section corresponds to one mixing box.*
- *Each ribbon on the detector is 2 by 128 fibers. The 2 is the inner and outer singlet layers. The 128 is on the circumference of the barrel or the phi direction.*
- *1/2 ribbons are used at the section boundary. These ribbons are 2 x 64.*
- *Each cassette has 8 groups of 128 inputs. Each of these groups is a MODULE.*
- *Each cassette has 2 FE boards such that 8 groups of 64 inputs go to each FE board. Each FE board is for the right or left half of a cassette.*

3. 128 Wide

One possibility is to make the wave guide harnesses with one connector for 256 fibers at the detector end and 2 connectors each for 128 fibers at the cassette end. The top part of figure 1 shows the cassettes layout for this possibility for a section of the detector. Fibers from the 2 A layer ribbons are plugged into 1/2 of the first cassette. (The 1/2 is front to back.) Fibers from 8 of the 8 1/2 ribbons of the F layer are plugged into the second cassette. The final 1/2 ribbon is plugged into the third cassette. And so on.

3.1 Backplane at the Digital Crate

The data is sent from the FE board to the digital board over a set of lvds links. Each link multiplexes the data into 7 time slices, 27 bits per. (The 28th bit is used as the crossing marker / synchronization flag.) Thus, each link carries 189 bits of data. There is 512 bits from each FE board, which can be carried over 3 links with 55 spare bits. Therefore the digital crate backplane would have 8 slots, one for each FE cassette, and each slot would have 6 links. The links plug into a transition board, which is plugged into the backside of the crate backplane. There are 8 transition boards each of which lands 6 links. A crate length backplane is then used to route the signals from the 8 transition boards to the 8 DG boards. A map of the input links onto this backplane is shown at the bottom of figure 1. This figure is a view from the front of the crate, each column is one FE cassette or digital board, and each row is a different set of links. The horizontal dashed lines in the upper drawing illustrate which parts of the cassette are sent over which links. The first cassette on the left has 6 links from two FE boards. Two of those links carry only A layer data, 2 only central preshower data and the final 2 carry a mixture of each.

3.2 Discussion of this Option

For this option, the two FE boards on the first cassette have preshower inputs and fiber inputs. These FE boards are different from any of the others. In addition, the preshower channels are shown with only one output per channel, not the high and low threshold desired by the preshower group. To accommodate this two extra links per FE board would need to be added at the cassette end and 4 input links added at the DG crate.

Another possibility is to put the A-layer fibers for the next detector section into the cassette, instead of the preshower. Then the next section only needs 7 more cassettes. In this way dedicated cassettes could be used for the preshower.

A significant down side of mixing A layer fibers from two different sections is that 2 links would carry A layer data from two different sections to the wrong crate. This data would have to be duplicated or routed from crate to crate.

4. 64 Wide

Another possibility is to make the wave guide harnesses with one connector for 256 fibers at the detector end and 4 connectors each of 64 fibers at the cassette end. The middle part of figure 1 shows the cassettes layout for this possibility for one section of the detector. Fibers from the 2 A-layer ribbons are plugged into 1/2 of the first cassette, but now on the right hand side. Fibers from 8 of the 8 1/2 ribbons of the F layer are plugged into the second cassette. The final 1/2 ribbon is plugged into the left side of the third cassette. And so on.

4.1 Backplane at the Digital Crate

A map of the input links onto this backplane is shown at the bottom of figure 1. The 3 links from the FE board for the A layer are plugged into the first row the 1^{st}, 4^{th}, and 7^{th} columns. The other columns in this row receive links from the FE boards for the F layer. Note that one link carries some F layer data and some D layer data. This link is plugged into the 3^{rd} column, 3^{rd} row.

Once the data is at the backplane, it has to be distributed to the proper digital boards. The details of this are not covered here. But it can be seen that the 3 A-layer inputs must be spread out to 8 DG boards. This backplane is very complicated.

4.2 Discussion of this Option

This option differs from the 128 option in several ways. First, there are fewer mixed links. Second, the preshower is in a dedicated FE board if not a dedicated cassette. Of course here too the next section's A-layer could be put into the preshower half cassette as above. Unlike the first option, in this case, the links could be routed directly to the proper DG crate.

5. Discussion

The trigger as outlined in sections 3 and 4 has a major flaw. There is no sharing of fiber information between the 5 sections or crates. This would result in 5 cracks in the tracker trigger. By simply looking at the geometry, this would result in up to $1/8^{th}$ of the area being inefficient for tracks. Much less than $1/8^{th}$ for high Pt but up to $1/8^{th}$ for Pt values below 2 GeV. To correct this over 10% loss in tracking efficiency, sharing of fiber data between crates is required.

Another flaw in this design is the shear size of the backplane. Each crate lands 8 x 6 = 48 links, each of which carry 189 bits of data plus clocks. The back plane would require 8 x 6 x (28 data + 2 clock) = 1440 traces. Many of these traces, which each originate at one link receiver, would terminate on two different DG boards. Moreover, some of them would need to be transmitted over a special cable or link to the neighbor crate. All of these traces are carrying data at 53 MHz.

This discussion has not touched on the details of the routing. For example the A-layer link landed on the first transition board the top link, has channels which must be routed to the first DG board, the first and second, the second, the second and third, and so on. Each of these sub-groups of traces will have different path lengths, which results in slightly different capacitive coupling and slightly different arrival times. Each sub-group thus needs a data valid clock and separate inputs in the PLD's for data and clock.

The separate DG board design sends the signals from a pair of FE boards to a single DG board. There are five FE crates of 16 boards each and two DG crates of 20 boards each. The options discussed here require five DG crates. Transforming the five into two would require that one of the five backplanes be split into two. The number of traces between these two would be very large. If the design were modified for five DG crates there would be a serious problem finding a location for them.

6. Summary

The fibers could be routed into the cassettes using a harness connecting one ribbon at the detector end to four 64-fiber connectors at the cassette end. Each of these 64 channel connectors would plug into the right or left half of a module top in the cassette assembly.

This change, however, would have serious repercussions for the DG board crates. The lvds links would have to be placed on transition boards at the rear of the crate backplane. This backplane would have to route some 1400 traces to multiple destinations. The backplane traces would span most of the crate width and would carry signals at 53 MHz. The timing and synchronization requirements for this are monumental.

In addition, links would have to be added to connect each of the 5 crates to its two neighbors. This adds even more of a timing and synchronization requirement.

To form a fast trigger the signals from the detector, which originate as ribbons, must be sorted into sectors. It is the opinion of the authors that doing

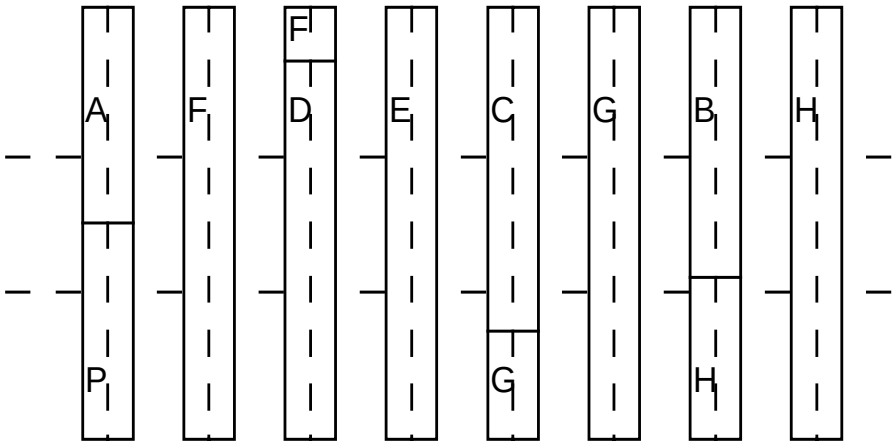
the sort in a passive patch panel is preferable to performing the sort on digital signals over a crate back plane.

Reference:
1- D0Note xxxx: Separate Digital board …
2- TDR version 5

7. Figures

CFT Cassettes for 1/5th of the Detector

128 Wide



DG Backplane

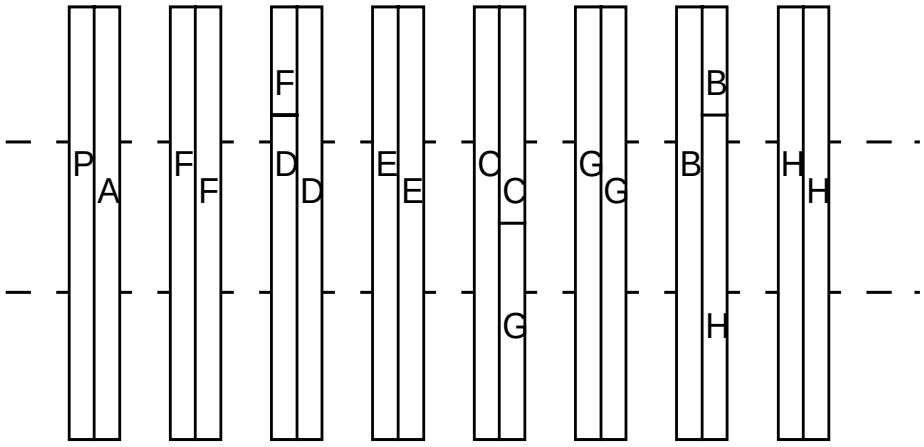
A	D	D	P	D	D	A	F/D
E	E	A/P	E	E	A/P	E	E
F	F	F/D	F	F	P	F	F
G	G	G	C/G	G	G	G	C/G
B	C	B/H	C	B	C	B/H	C
H	H	H	H	H	H	H	H

wide_128

Figure 1 View of the cassette tops and DG backplane for the 128 wide design option.

CFT Cassettes for 1/5th of the Detector

64 Wide



DG Backplane

A	D	D	A	D	D	A	D
E	E	P	E	E	P	E	E
F	F	F/D	F	F	P	F	F
G	G	G	C/G	G	G	G	G
B	C	B/H	C	B	C	B	C
H	H	H	H	H	H	H	H

wide_64

Figure 2 View of the cassette tops and DG backplane for the 64 wide design option.